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THE MURRAY-DARLING RIVER SYSTEM

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ABSTRACT: The Murray-Darling river system is a product of the continent over which it flows, and so has remarkably low declivities (once the Dividing Range is left) and low water volumes although subject to heavy floods. Clay-rich substrates ensure the continuation of river flow over great distances in spite of low water volumes and high evaporation. These characteristics of the river course control the nature of the biota. The Pleistocene Murray extended 180 km further (across the continental shelf), and considerably increased its potential energy by debouching about 200 m lower.

INTRODUCTION

Derivationally, a river is a *divider*, viz. that which *rives*, and the people on each side are *rivals*. But from a scientific point of view, a river is a *process*, viz. water flowing across a terrain. Still water is not a river, but a lake or billabong. The nature of the process is determined by four factors: (1) The volume and energy of the water, (2) the nature of the water, (3) the substrate, and (4) the subaerial environment.

MURRAY-DARLING WATERS

Australia is the only mid-plate continent, so its tectonics are subdued, and it is the flattest continent. Because Australia lacks high mountains, is extensive, and lies in the dry latitudes, it is not only the flattest but also the driest continent. These two attributes result in the Murray-Darling being a most unusual river system. The natural Murray is of course different from the present controlled stream. For example, in 1945 I walked dry shod across the bed of the Murray near Koondrook, but controls now prevent the river from going dry.

The Murray and Darling Rivers both rise in the so-called Great Dividing Range, but have quite different hydrologic and time parameters. The Darling results from the tropical/subtropical rainfall on the Divide. It is essentially monsoon water that falls in summer. By contrast, the Murray results from temperate zone rainfall. Its water is from winter rain and spring thaw. King floods occur below the confluence of these two rivers when their floods happen to coincide. The Murray/Darling catchment is about one seventh of the continent, but the volume of water carried is small because most of the course across the plains is through semi-arid country. The Mississippi carries 20 times as much water and the Amazon 75 times.

MURRAY-DARLING RIVER COURSES (Pl. 1)

On leaving the mountains, the rivers traverse wide plains of semi-arid country. If the Darling flowed into sandy country like that of northwest Victoria, it would never meet the Murray. Substrate is here a significant factor. Widespread lateritization and bauxitization of the terrain has produced non-swelling clays, while the basalts of the Divide have produced montmorillonite. Clay-lined channels prevent loss of water by seepage. So the Darling is not lost in a sandy desert; it has many of the properties of a canal. It is the Nile of Australia. Downstream from Albury, the Murray runs through semi-arid country, where extensive clayey deposits such as the Blanchetown Clay have a profound effect on the nature of the system.

Growing curious about the course of the Murray River west of Mildura, I studied why it should run the course it does, when in such flat country so many other possibilities appear to be present. And why is the north bank commonly cliffed, but not the south? I discovered that the river follows essentially the boundary between the clayey country to the north and the sandy country to the south. For example, on the north side farmers conserve water in *tanks* which are shallow basins cut in Blanchetown Clay or such clayey sediments. On the south side the farmers dig *waterholes* which are in sand and have to be lined with clay. Once a year the channels to the waterholes are cleared, and they are filled with water from Lake Cullulleraine (for

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example), but about 90% of the water is lost through the sandy channels. However, the aquifers are so charged.

Because of the flow of rivers over dry flat country, and so few tributaries once the mountains and foothills are left behind, and because of the high evaporation rate (up to 2 m p.a.), the water volume of the Murray-Darling System is far below average. In those dry areas, water becomes the most precious of minerals.

MURRAY-DARLING SEDIMENTS

Clayey aquicludes play an important part in the organization of the river system and its hydrology. But what of the aquifers? The water table in the proposed Chowilla Dam area is 60 m from the surface. Because of the low declivity of the terrains, coarse sediments remain in the upper reaches of the rivers, and fine sediments characterize the Murray Basin deposits. On the Darling River between the Queensland border and the confluence with the Murray the energy levels are low and the sediments fine. The river length is x3 the direct distance (*c.* 2,100 km) with an average fall of only 5-6 cm/km (3½"/mile). As the evaporation is *c.* 2 m/yr, carbonates load the terrain — calcite, gypsum, dolomite and barite. The river is characterized by the fineness of its sediments. An interesting example of the fineness of the sediments is that the 14 km long lunette on the east side of Lake Victoria does not consist of the usual medium sand, but of fine sand, because only fine sand is available. Because the sand is so light, it was almost always in a state of blowout during the construction of the lunette, so that there are more windblown horizontal beds than the usual 22°/33° dune structures, although these also are present.

The fineness of the sediments also influences the hydrology in that the fine sands hold more water than coarse ones. The biology is profoundly affected by this system of low energies and fine sediments. Extensive weed-growing areas exist with fish and other forms of life capable of withstanding the muddy waters and low oxygen status. For this reason introduced fish such as the European carp and redfin have done well, and trout are limited to the higher reaches of these rivers. The biota has to be able to exist in an ecosystem that consists at one time (under natural conditions) of a string of ponds, while at another it consists of a great flood up to 100 km wide.

The mild tectonics of this region result in a broad inland plain with but little relief, so flat indeed that any movement that does occur has effects quite out of proportion with its size. For example, the Cadell

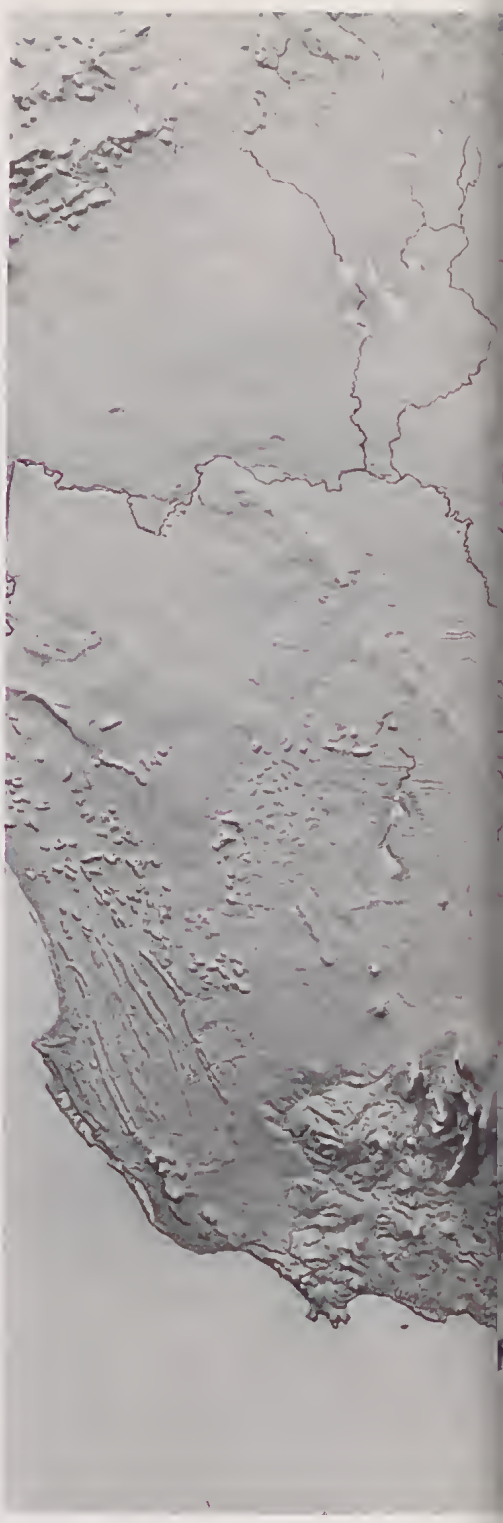

PLATE 1

Photograph by J. Walsh (CSIRO Division of Applied Geomechanics) of a model(by Professor E. S. Hills)of southeast Australia, showing the flat subquadrate Murray Basin surrounded by a frame of ancient sedimentary and plutonic rocks. The Darling River is shown flowing south to meet the Murray River, whose origin is in the Eastern Highlands.

Fault at Echuca, with a maximum throw of 12 m, diverted the Murray River south along the fault line to betrunk the Goulburn River, taking over some 80 km of its course. Some water forms an anabranch to the north. So this minor fault strongly diverted Australia's largest river, and created the Echuca Depression in which a lake was formed, and from the sandy beaches of which the Bama Sandhills were built. Because of the gentle tectonics, old faults and lineaments have not been destroyed in an upheaved crust, but slow movements have continued on them for hundreds of millions of years. Thus the faults in the Pre-Cambrian basement have for the past 120 m.y. influenced the Murray Basin in spite of 1,000 m of cover in places. Small movements still occur on these very ancient faults with remarkable effects because of the flatness of the terrain, e.g. the formation of Lake Victoria.

So the ecosystem of Australia's largest river system is a most remarkable one, and merits much more study. There is a fascinating interdependence between all the elements that make up this ecosystem — the geology, geomorphology, climate, hydrology and biology. This Symposium was organized in the hope of achieving a greater integration of the vast amount of information available.

MURRAY DEBOUCHEMENT

The Darling River debouches into the Murray River at Wentworth, but with a twin stream, the Darling Anabranch. Wentworth is about 820 km by river from the sea, but only a little over 30 m above sea level. At Murray Bridge the granite bars below the river sediments are 40 m below sea level, the bed having been cut low during times of low sea level. Before entering the sea the river debouches into Lake Alexandria which is practically horizontal (declivity of 1"/mile, say 1 cm/km). This lake is a creation of the Flandrian Transgression. From the Murray mouth to the edge of the continental shelf is 180 km, a declivity of 1 in 900. There are submarine canyons on the edge of the continental shelf, and these are commonly regarded as old mouths of the Murray. Certainly when sea level was low, the course of the Murray was much longer, and the lower part at least of its system would be rejuvenated by the provision of a lower base level.

HISTORY OF THE MURRAY-DARLING SYSTEM

The drainage of this area was first provided for by two great events: the retreat of the Cretaceous epeiric seas, which provided a terrain, and the separation of Antarctica and Australia, which provided a coast onto which rivers could flow. Changing world climates, and the changing position of the Australian continent as it drifted north have been major influences. Much of the story is unknown, but the Tertiary sea did invade the Murray Basin, in the Miocene reaching as far as Deniliquin, thus strongly betrunking the rivers. Some think that the Darling did not break through the Cobar Gap until the Pliocene. Certainly in the Miocene the climate was subtropical with high rainfall and forests including *Araucaria* and *Agathis* as far south as Victoria, where large crocodilians were also to be found. In the Pliocene laterites were formed, indicating a monsoon type climate. Then the forests disappeared and sclerophyll plants came to dominate the region, and carbonates instead of iron came to dominate the surface chemistry.

After the sea retreated from the Murray Basin, the Pinnaroo Block was uplifted in the South Australian sector, so that a great freshwater lake or series of lakes formed inland called Lake Bungunnia. For the present, it is something of a mystery how and when the present lower Murray course as we know it became established. But it has cut a course through this block, forming the Murray Gorge, along the walls of which can be seen the Miocene and Pliocene sediments laid down by the marine transgression. So the Murray-Darling ecosystem is one that reaches far into a past with great changes in the nature of the environment. This is a history that we are only beginning to unravel.